ISSN- 0301-1216
Indian J. Prev. Soc. Med. Vol. 57, No.3, 2026

Clinico-Epidemiological Profile, Factors Associated with Weight Gain, and Nutritional Outcomes among Children with Severe Acute Malnutrition Admitted to a District Nutritional Rehabilitation Centre in Maharashtra

Harish Kunde[1], Prakash L Gattani[2], Sainath L Maidapwad[3]

ABSTRACT

Background: Severe Acute Malnutrition (SAM) remains a major contributor to childhood morbidity and mortality in India. Nutritional Rehabilitation Centres (NRCs) provide facility-based management for SAM; however, evidence regarding long-term nutritional outcomes following discharge and follow-up remains limited. **Objectives:** To describe the clinico-epidemiological profile of children with Severe Acute Malnutrition admitted to a district-level Nutritional Rehabilitation Centre, assess selected associated factors, and evaluate nutritional outcomes following rehabilitation and follow-up. **Methods:** A prospective longitudinal study was conducted among 120 children aged 6–59 months with Severe Acute Malnutrition admitted to a District Nutritional Rehabilitation Centre Nanded District in Maharashtra between May 2024 and April 2026. An information specifically socio-demographic characteristic, maternal factor, feeding practices and environmental conditions were collected using a pretested semi-structured questionnaire. Anthropometric measurements, including weight (kg), height/ length (cm), mid-upper arm circumference (MUAC in cm) and chest circumference (cm) were recorded at admission, discharge and follow-up visits. Data were analysed using IBM SPSS Statistics Version 29.0. **Results:** The mean age of participants was 29.75±16.42 months, and 60.8% were females. Most children belonged to lower socioeconomic strata (95.8%). Mean weight increased from 7.91±2.11 kg at admission to 9.23±2.22 kg at discharge and continued to improve during follow-up ($p<0.001$). Mean weight gain velocity was 11.76±4.56 g/kg/day. Maternal education was significantly associated with long-term weight gain ($p<0.001$), while family size showed a significant negative correlation with weight gain during NRC stay ($p=0.008$). **Conclusion:** Nutritional rehabilitation through NRC services resulted in significant improvement in anthropometric outcomes among children with Severe Acute Malnutrition. Strengthening caregiver counselling and community-based follow-up seems to further enhance long-term nutritional recovery.

Keywords: Severe Acute Malnutrition; Nutritional Rehabilitation Centre; Nutritional Recovery; Anthropometry; Follow-up Assessment; Child Nutrition.

Author(s) Details:

1. In-service Medical Officer cum Junior Resident, Department of Community Medicine, Dr Shankarrao Chauhan, Government Medical College, Nanded, Maharashtra, India
2. Professor and Head, Department of Community Medicine, Dr Shankarrao Chauhan, Government Medical College, Nanded, Maharashtra, India
3. Statistician cum Assistant Professor, Department of Community Medicine, Dr. Shankarrao Chauhan Government Medical College, Nanded, Maharashtra, India

Corresponding Address: Dr Harish Kunde, Department of Community Medicine, SRTM University Campus, GMC, Nanded, Maharashtra, **Email:** dr.harishkunde@gmail.com, Mobile:8208407513

Citation: Kunde H., Gattani PL., Sainath L Maidapwad .Clinico-Epidemiological Profile, Factors Associated with Weight Gain, and Nutritional Outcomes among Children with Severe Acute Malnutrition Admitted to a District Nutritional Rehabilitation Centre in Maharashtra. Indian J Prev Soc Med, 2026; 57 (3): **256-269**. **DOI:** https://doi.org/10.67212/ijpsm.v57i3.272

Sequence of Article: **Submission: 25.06.2026** **Accepted: 12.09.2026** **Published: 30.09.2026**

Prior Publication: Nil; Source of Funding: Nil; Conflicts of Interest: None, Article # 203/275-277

Introduction

Malnutrition remains one of the most significant public health challenges affecting children under five years of age worldwide. Severe Acute Malnutrition (SAM), the most severe form of undernutrition, is associated with a markedly increased risk of morbidity, mortality, impaired cognitive development and poor long-term health outcomes.[1,2] According to the World Health Organisation (WHO), SAM is defined as a weight-for-height/length Z-score below −3 standard deviations of the WHO Child

Growth Standards median, a mid-upper arm circumference (MUAC) less than 11.5 cm, or the presence of bilateral pitting oedema[2]. Children with SAM are at a substantially higher risk of death compared to their well-nourished counterparts and often suffer from recurrent infections, delayed growth and developmental impairments.[3,4]

Despite considerable progress in maternal and child health programmes, India continues to bear a substantial proportion of the global burden of childhood malnutrition.[5] Findings from the National Family Health Survey-5 (NFHS-5) indicate that undernutrition remains a major concern among under-five children, with significant proportions affected by wasting, stunting and underweight.[4] Severe acute malnutrition continues to contribute substantially to childhood illness, hospitalisation, and mortality, particularly among socio-economically disadvantaged populations.[3,7] The consequences of SAM extend beyond childhood and may adversely affect educational attainment, productivity and health outcomes in adulthood[10].

The aetiology of Severe Acute Malnutrition is multifactorial and involves a complex interplay of biological, socioeconomic and environmental determinants. Poverty, food insecurity, inadequate infant and young child feeding practices, recurrent infections, poor environmental sanitation, low maternal education and limited access to healthcare services have all been identified as important contributors to childhood undernutrition.[3,7,8,9] These factors often coexist and reinforce one another, creating a vicious cycle of malnutrition and disease. Therefore, effective management of SAM requires a comprehensive approach addressing both medical complications and underlying nutritional deficiencies.

To address the burden of severe acute malnutrition, Nutritional Rehabilitation Centres (NRCs) have been established under the National Health Mission (NHM) across India to provide facility-based management of SAM children.[10,11] NRCs offer therapeutic feeding, medical management of complications, nutrition counselling and caregiver education aimed at promoting recovery and preventing relapse. Several studies have demonstrated favourable short-term outcomes following NRC admission, including improvement in body weight, nutritional status and survival.[12,13] However, evidence regarding long-term nutritional recovery after discharge remains limited, particularly in programme settings.

Sustained nutritional recovery following discharge is crucial for preventing relapse and ensuring normal growth and development. Long-term follow-up of children treated for SAM provides valuable information regarding the effectiveness of nutritional rehabilitation services and helps identify factors associated with recovery.[14, 15.] Understanding the clinico-epidemiological profile and associated factors among children with SAM can further assist programme managers and policymakers in strengthening preventive and rehabilitative interventions.

Maharashtra has implemented facility-based management of severe acute malnutrition through Nutritional Rehabilitation Centres; however, limited evidence is available regarding long-term anthropometric outcomes and factors associated with nutritional recovery among admitted children. In this context, the present study was undertaken to describe the clinico-epidemiological profile, selected associated factors and nutritional outcomes among children with Severe Acute Malnutrition admitted to a District Nutritional Rehabilitation Centre, District Women Hospital, Nanded District, Maharashtra and followed up after discharge.

Objectives

***Aim*:** To study the clinico-epidemiological profile, selected associated factors and nutritional outcomes among children with Severe Acute Malnutrition admitted to a District Nutritional Rehabilitation Centre in Maharashtra.

***Objectives*:** To describe the clinico-epidemiological profile of children with Severe Acute Malnutrition. To assess selected associated factors among children with Severe Acute Malnutrition. To evaluate nutritional outcomes by comparing anthropometric parameters at admission, discharge and follow-up.

Materials and Methods

***Study Design and Setting*:** A prospective longitudinal study was conducted at the District Nutritional Rehabilitation Centre (NRC), District Women Hospital, Nanded District, Maharashtra. The NRC is a facility-based centre established under the National Health Mission (NHM) to manage and provide nutritional rehabilitation for children with Severe Acute Malnutrition (SAM). The study was designed to assess the clinico-epidemiological profile, selected associated factors and nutritional outcomes among SAM children admitted to the NRC and followed up after discharge.

***Study Duration*:** The study was conducted over a period of 24 months from May 2024 to April 2026. The study period included participant enrolment, inpatient stay at the NRC, discharge assessment and post-discharge follow-up evaluations.

***Study Population*:** The study population comprised children aged 6–59 months diagnosed with Severe Acute Malnutrition and admitted to the District Nutritional Rehabilitation Centre during the study period.

***Inclusion Criteria*:** Children aged 6–59 months fulfilling any of the following WHO criteria for Severe Acute Malnutrition were included in the study:

- Weight-for-height/length Z-score below −3 standard deviations (SD) from the WHO Child Growth Standards median.
- Mid-upper arm circumference (MUAC) less than 11.5 cm.
- Presence of bilateral pitting oedema of nutritional origin.

Children whose parents or caregivers provided written informed consent were enrolled in the study.

Exclusion Criteria

- Children whose parents or caregivers refused consent.
- Children with major congenital anomalies, genetic disorders or chronic debilitating illnesses are likely to independently influence growth and nutritional status.

***Sample Size and Sampling Technique*:** The sample size was calculated using the single population proportion formula:

$n = Z^2pq/d^2$

Where:

n = required sample size

Z = standard normal deviate corresponding to a 95% confidence level (1.96)

p = prevalence of Severe Acute Malnutrition (7.7%)

q = 1 − p (92.3%)

d = absolute precision (5%)

Using a prevalence of Severe Acute Malnutrition of 7.7% reported in NFHS-5, the calculated minimum sample size was approximately 109 children. To improve study precision and account for potential attrition during follow-up, the sample size was increased to 120 children.

A consecutive sampling technique was adopted. All eligible children admitted to the Nutritional Rehabilitation Centre during the study period who met the inclusion criteria were enrolled consecutively until the required sample size was reached.

Data Collection: Data were collected using a pretested semi-structured questionnaire administered to parents or caregivers. Information regarding socio-demographic characteristics, maternal factors, birth history, infant and young child feeding practices, immunisation status, environmental sanitation and clinical characteristics was obtained through caregiver interviews and review of available records. Socioeconomic status was assessed using the Modified B.G. Prasad socioeconomic classification based on monthly per-capita family income. The socioeconomic classification was updated according to the Consumer Price Index for Industrial Workers (CPI-IW) applicable during the study period. Participants were accordingly classified into socioeconomic Classes I to V.

Anthropometric Assessment: Anthropometric measurements were recorded at admission, discharge and scheduled follow-up visits using standard WHO-recommended procedures. Body weight was measured using a calibrated digital weighing scale and recorded to the nearest 0.1 kg. Length of children below two years of age was measured using an infantometer, while standing height of children aged two years and above was measured using a stadiometer and recorded to the nearest 0.1 cm.

Mid-upper arm circumference (MUAC) was measured at the midpoint between the acromion and olecranon processes of the left arm using a standard non-stretchable MUAC tape (Shakir's Tape). Chest circumference was measured using a non-stretchable measuring tape at the level of the nipples during normal respiration.

Outcome Variables

Primary Outcome Measures

- Body weight (kg)
- Height/Length (cm)
- Mid-upper arm circumference (cm)
- Chest circumference (cm)

Secondary Outcome Measures

- Weight gain during NRC stay
- Weight gain velocity
- Nutritional recovery during follow-up
- Association of selected factors with nutritional outcomes

Weight gain during the NRC stay was assessed using weight gain velocity, calculated as the difference between discharge and admission weight relative to admission weight and duration of stay, and expressed as g/kg/day. A weight gain velocity of ≥5 g/kg/day was considered satisfactory, whereas a weight gain velocity of <5 g/kg/day was considered unsatisfactory. This criterion was used to classify children into satisfactory and unsatisfactory weight-gain groups for subsequent analysis.

Follow-up Assessment: Children were followed prospectively after discharge according to the NRC follow-up protocol. Anthropometric assessments were performed during scheduled follow-up visits every 15-day interval, up to 360 days post-discharge. Information regarding feeding practices, morbidity episodes and nutritional status was documented during follow-up assessments. All enrolled participants completed follow-up evaluations. No mortality and no loss to follow-up were recorded during the study period.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The Chi-square test was used to assess associations between categorical variables. Student's t-test was applied for comparison of means between two groups, while one-way analysis of variance (ANOVA) was used for comparison

among more than two groups. Pearson's correlation coefficient was used to assess relationships between continuous variables. A p-value less than 0.05 was considered statistically significant.

Ethical Considerations: The study was approved by the Institutional Ethics Committee vide Approval No. 431 dated 17/05/2024. Written informed consent was obtained from the parents or caregivers of all study participants before enrolment. Confidentiality and anonymity of participants were maintained throughout the study in accordance with ethical principles governing biomedical research involving human participants.

Results

***Socio-demographic Profile*:** Table 1 and 2 presents the association between selected socio-demographic, socio-economic and infant-feeding characteristics and weight-gain outcome during the NRC stay among 120 children with Severe Acute Malnutrition. Of the 120 children, 112 (93.3%) achieved satisfactory weight gain, while 8 (6.7%) had unsatisfactory weight gain. Unsatisfactory weight gain was more frequently observed among children from rural areas (75.0%), those whose mothers had education up to primary level (62.5%), children from families with more than five members (62.5%), and those belonging to Modified BG Prasad socioeconomic Classes IV–V (75.0%). Similarly, unsatisfactory weight gain was observed more frequently among children who were exclusively breastfed for less than 6 months (50.0%) and those with delayed complementary feeding (37.5%).

Table-1: Socio-demographic profile of study participants (N = 120)

Variable	Category	No.	%
Age Group	0–5 months	4	3.3
	6–11 months	23	19.2
	12–23 months	30	25.0
	24–35 months	25	20.8
	36–59 months	38	31.7
Gender	Male	47	39.2
	Female	73	60.8
Religion	Hindu	83	69.2
	Buddhist	33	27.5
	Muslim	4	3.3
Type of Family	Nuclear	105	87.5
	Joint	6	5.0
	Three Generation	8	6.7
	Broken Family	1	0.8
Residence	Urban	67	55.8
	Rural	53	44.2
Socio-economic status	Class II	1	0.8
	Class III	4	3.3
	Class IV	48	40.0
	Class V	67	55.8
Maternal education	Illiterate	27	22.5
	Primary	66	55.0
	7^{th} –10^{th} standard	21	17.5
	HSC	6	5.0
Maternal occupation	Homemaker	114	95.0
	Daily wage labour	6	5.0
Birth weight	<1.5 kg	3	2.5
	1.5–2.49 kg	44	36.7
	2.5–3.49 kg	71	59.2
	≥3.5 kg	2	1.7

Table-2: Weight gain in study participants

Variable	Category	Satisfactory weight gain		Unsatisfactory weight gain		P value
		No.	%	No.	%	
Residence	Rural	60	53.6	6	75.0	0.041*[a]
	Urban	52	46.4	2	25.0	
Maternal education	≤ Primary	18	16.1	5	62.5	0.002*[a]
	> Primary	94	83.9	3	37.5	
Family size	>5 members	24	21.4	5	62.5	0.008*a
	≤5 members	88	78.6	3	37.5	
Socioeconomic status	Modified BG Prasad Class IV–V	39	34.8	6	75.0	0.015*[a]
	Class II–III	73	65.2	2	25.0	
Exclusive breastfeeding	<6 months	27	24.1	4	50.0	0.047*[a]
	≥6 months	85	75.9	4	50.0	
Delayed complementary feeding	Yes	20	17.9	3	37.5	0.086
	No	92	82.1	5	62.5	

A statistically significant association was observed between weight-gain outcome and residence (p=0.041), maternal education (p=0.002), family size (p=0.008), socioeconomic status (p=0.015), and duration of exclusive breastfeeding (p=0.047). Delayed complementary feeding was not statistically significantly associated with weight-gain outcome (*p*=0.086). These findings indicate that household socioeconomic characteristics, maternal educational attainment, family size and early feeding practices were associated with weight-gain performance during nutritional rehabilitation. The inclusion of infants below 6 months reflects actual routine NRC admissions during the study period, for whom separate criteria for severe acute malnutrition and inpatient management are recognized (Table-2).

Figure-1: Bar diagram shows the age distribution of the study participants (N=120)

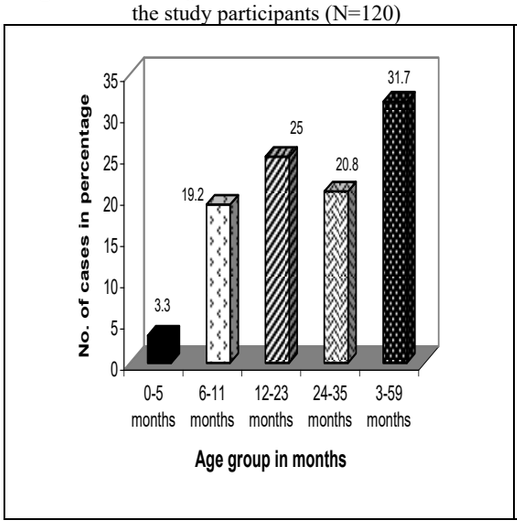


Figure-2: Socioeconomic Class-Wise Distribution of the Study Participants

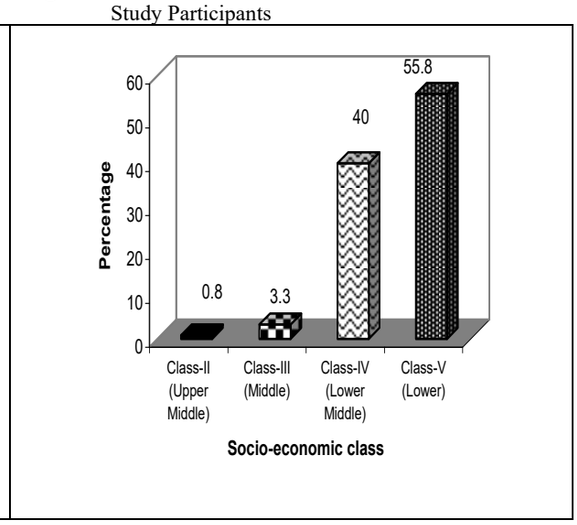


Figure-3: Maternal education wise distribution of the study participants (N=120).

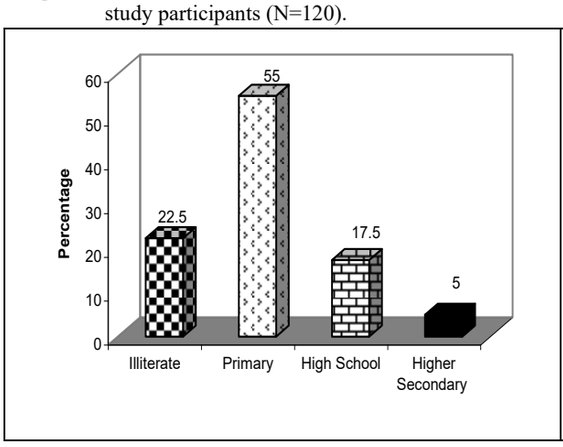


Figure-4: Showing the distribution according to birth weight (N=120).

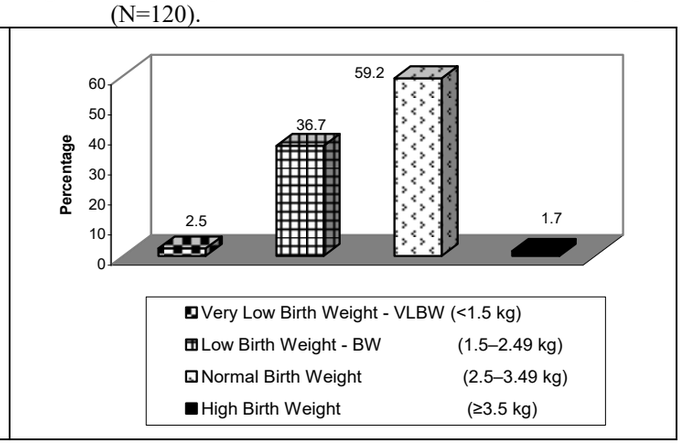


Table- 3: Environmental Sanitation and Hygiene Risk Factors (N = 120)

Environmental Variables		No.	%
Gross Environmental Sanitation	Satisfactory (S)	4	3.3
	Not Satisfactory (NS)	116	96.7
Personal Hygienic Practices	Satisfactory (S)	2	1.7
	Not Satisfactory (NS)	118	98.3
Biological Environment	Not Satisfactory (NS)- All 120 participants	120	100.0

Table 3 presents the environmental and personal hygiene risk factors. Gross environmental sanitation was unsatisfactory in 96.7% (n=116) of households. Personal hygienic practices were unsatisfactory in 98.3% (n = 118). The biological environment including the presence of disease vectors, overcrowding, and animal contamination was unfavourable in all 120 families (100%). These findings highlight the near-universal prevalence of adverse environmental conditions in this study population, constituting a major underlying cause of malnutrition.

Table-4: Serial Changes in Body Weight (kg) Admission to 360 Days Post-Discharge (N = 120).

Time Point	Mean Weight (kg)± SD	Mean Diff vs. Admission (kg)	p-value vs. Admission (Paired t-test)
Admission (Day 1)	7.91 ± 2.11	---	Reference
Discharge (Day 15)	9.23 ± 2.22	+ 1.32	<0.001***
Day 7 Post-Discharge	9.40 ± 2.23	+ 1.48	<0.001***
Day 30 Post-Discharge	10.01± 2.33	+ 2.10	<0.001***
Day 90 Post-Discharge	11.54± 2.59	+ 3.63	<0.001***
Day 180 Post-Discharge	13.52± 3.14	+ 5.61	<0.001***
Day 360 Post-Discharge	17.53± 4.53	+ 9.62	<0.001***

Paired t-test comparing each time-point to Admission (Day 1). P-value <0.05 was considered statistically significant

Table-4 presents the longitudinal progression of mean body weight from admission through 360 days post-discharge. The mean weight at admission was 7.91±2.11 kg, rising to 9.23±2.22 kg at discharge (Day 15), a mean gain of 1.32 kg. Statistically significant weight gains were recorded at every subsequent time-point relative to admission (all p<0.001, paired t-test).

By Day 360 post-discharge, the mean weight reached 17.53 ± 4.53 kg, representing a total mean gain of 9.62 kg over the entire study period, reflecting the sustained effect of both inpatient and community-based nutritional interventions.

Table- 5: Serial Changes in Mid-Upper Arm Circumference MUAC (cm) Admission to 360 Days Post-Discharge (N = 120)

Time Point	Mean MUAC (cm) ± SD	Mean Diff vs. Admission (cm)	p-value vs. Admission (Paired t-test)
Admission (Day 1)	12.67 ±0.89	----	Reference
Discharge (Day 15)	12.96 ±0.91	+0.28	< 0.001***
Day 7 Post-Discharge	12.97 ±0.91	+0.30	< 0.001***
Day 30 Post-Discharge	13.03 ±0.91	+0.36	< 0.001***
Day 90 Post-Discharge	13.19 ±0.93	+0.51	< 0.001***
Day 180 Post-Discharge	13.39 ±0.98	+0.72	< 0.001***
Day 360 Post-Discharge	14.08 ±1.07	+1.40	< 0.001***

Paired t-test comparing each time-point to Admission (Day 1). P-value <0.05 was considered statistically significant

Table 5 shows the progressive improvement in mean MUAC throughout the study period. At admission, the mean MUAC was 12.67 ± 0.89 cm. Statistically significant increases were recorded at every post-admission time-point (all $p<0.001$). A mean gain of 0.28 cm was achieved by discharge (Day 15). By Day 360 post-discharge, the mean MUAC reached 14.08 ± 1.07 cm, representing a total mean gain of 1.40 cm. As MUAC ≥12.5 cm corresponds to the green zone of the MUAC tape (nutritional recovery), the progressive increase across all time-points demonstrates sustained and consistent nutritional recovery throughout follow-up.

Table -6: Serial Changes in Chest Circumference (cm) Admission to 360 Days Post-Discharge (N = 120)

Time Point	Chest Circumference (cm) Mean ± SD	Mean Diff vs Admission (cm)	p-value vs Admission (Paired t-test)
Admission (Day 1)	41.63 ± 7.00	---	Reference
Discharge (Day 15)	41.85 ± 7.20	+0.22	0.007**
Day 7 Post-Discharge	41.87 ± 7.21	+0.24	0.003**
Day 30 Post-Discharge	41.97 ± 7.22	+0.34	< 0.001***
Day 90 Post-Discharge	42.22 ± 7.26	+0.59	< 0.001***
Day 180 Post-Discharge	42.61 ± 7.32	+0.98	< 0.001***
Day 360 Post-Discharge	43.94 ± 7.42	+2.31	< 0.001***
Paired t-test comparing each time-point to Admission (Day 1). P-value <0.05 was considered statistically significant			

Table 6 documents the serial changes in chest circumference. The mean chest circumference at admission was 41.63 ± 7.00 cm. A statistically significant increase was observed at discharge (41.85 ± 7.20 cm; $p = 0.007$), and continued significantly at all post-discharge time-points ($p<0.001$ from Day 30 onwards). By Day 360, the mean reached 43.94 ± 7.42 cm, with a total mean gain of 2.31 cm. The incremental and sustained improvement in chest circumference across the follow-up period reflects progressive somatic recovery following NRC intervention.

Table-7: Serial Changes in Height / Length (cm) Admission to 360 Days Post-Discharge (N = 120)

Time Point	Mean Height / Length (cm) ± SD	Mean Diff vs Admission (cm)	p-value *vs.* Admission (Paired t-test)
Admission (Day 1)	79.78 ±11.83	—	Reference
Discharge (Day 15) [a]	79.78 ±11.83	≈ 0.00	NA [a]
Day 7 Post-Discharge	79.79 ±11.83	+0.01	< 0.001***
Day 30 Post-Discharge	79.89 ±11.82	+0.12	< 0.001***
Day 90 Post-Discharge	80.29 ±11.84	+0.52	< 0.001***
Day 180 Post-Discharge	80.89 ±11.85	+1.11	< 0.001***
Day 360 Post-Discharge	82.89 ±11.92	+3.11	< 0.001***
Paired t-test comparing each time-point to Admission (Day 1). P-value <0.05 was considered statistically significant			

Table 7 summarises the longitudinal height or length measurements from admission to Day 360. Height at discharge (Day 15) was essentially identical to admission values for all 120 participants. However, statistically significant linear gains were recorded from Day 7 post-discharge onwards ($p<0.001$), indicating that even in the early post-discharge period, continued nutritional support and community follow-up facilitated meaningful linear growth. By Day 360, the mean height reached 82.89 ± 11.92 cm, with a total gain of 3.11 cm from admission ($p<0.001$). The progressive and sustained linear growth trajectory from Day 7 onwards underscores the effectiveness of the comprehensive NRC protocol, including post-discharge follow-up.

Table -8: Weight Gain Velocity During NRC Stay Overall Summary (N = 120)

Parameter	No.	Mean ± SD
Mean Weight Gain — Admission to Discharge (kg)	120	1.32 ± 0.40
Mean Weight Gain Velocity (gm/kg/day)	120	11.76 ± 4.56
Children with Satisfactory Gain (≥ 5 gm/kg/day)	112	93.3%
Children with Unsatisfactory Gain (< 5 gm/kg/day)	8	6.7%

Weight gain velocity= [(Weight (Kg) Day 15 − Weight (Kg) Day 1) ÷ Weight (Kg) Day 1 X 15] X 1000

Satisfactory criterion: ≥ 5 gm/kg/day (WHO / NRC Protocol). N = 120

Table 8 presents the overall weight gain performance during the 15-day NRC stay. The mean weight gain was 1.32 ± 0.40 kg, yielding a mean velocity of 11.76 ± 4.56 gm/kg/day substantially exceeding the WHO/NRC protocol criterion of ≥ 5 gm/kg/day. The vast majority of children (93.3%, n = 112) achieved satisfactory weight gain, while 6.7% (n = 8) did not meet the threshold, reflecting highly effective inpatient therapeutic nutritional management in the study NRC.

Table-9: Summary Comparison of All Anthropometric Parameters at Key Time-Points (N = 120).

Parameter	Admission (Day 1)	Discharge (Day 15)	Post-Discharge		p-value Admission vs 360 day
			Day 90	Day 360	
Weight (kg)	7.91±2.11	9.23±2.22	11.54±2.59	17.53±4.53	<0.001***
MUAC (cm)	12.67±0.89	12.96±0.91	13.19±0.93	14.08±1.07	<0.001***
Chest Circ. (cm)	41.63±7.00	41.85±7.20	42.22±7.26	43.94±7.42	<0.001***
Height/Length (cm)	79.78±11.83	79.78±11.83	80.29±11.84	82.89±11.92	<0.001***

Paired t-test comparing each time-point to Admission (Day 1). P value <0.05 was considered as statistically significant

Table 9 provides a consolidated comparison of all four anthropometric parameters weight, MUAC, chest circumference, and height/length at four key time-points: admission, discharge, Day 90, and Day 360 post-discharge. All four parameters showed highly statistically significant improvement from admission to Day 360 ($p < 0.001$ for all, paired t-test). The largest absolute gain was in body weight (7.91 to 17.53 kg, a mean increase of 9.62 kg), followed by linear height (79.78 to 82.89 cm, +3.11 cm). The consistent and sustained improvement in all anthropometric parameters across the entire study period reflects the combined effectiveness of inpatient NRC care and community-based follow-up.

Table-10: Factors Associated with Unsatisfactory Weight Gain during NRC Stay

Variables	Satisfactory Gain (N=112)		Unsatisfactory Gain (n=8)		p-value
	No.	%	No.	%	
Rural residence	60	53.6	6	75.0	0.041*
Maternal education ≤ Primary	18	16.1	5	62.5	0.002*
Family size > 5 members	24	21.4	5	62.5	0.008*
SES Class IV & V	39	34.8	6	75.0	0.015*
Exclusive breastfeeding <6 months	27	24.1	4	50.0	0.047*
Delayed complementary feeding	20	17.9	3	37.5	0.086

Table-11: Comparison of Baseline Characteristics by Weight Gain Outcome

Parameter	Mean ± SD		p-value
	Satisfactory Gain (n=112)	Unsatisfactory Gain (n=8)	
Age (months)	24.8 ± 10.6	26.4 ± 9.8	0.621
Birth Weight (kg)	2.41 ± 0.34	2.53 ± 0.28	0.289
Family Size	3.74 ± 1.42	5.50 ± 1.07	0.001*
Duration of EBF (months)	6.05 ± 0.74	5.00 ± 1.20	0.012*

Tables 10 and 11 depict that out of the 120 SAM children admitted to the NRC, 112 (93.3%) achieved satisfactory weight gain velocity, while 8 (6.7%) showed unsatisfactory weight gain. Unsatisfactory weight gain was more common among children belonging to larger families, lower socioeconomic classes, rural households, and those whose mothers had lower educational attainment. Inadequate breastfeeding practices were also more frequently observed among children with poor weight gain. These findings suggest that socioeconomic and care giving factors may influence the effectiveness of nutritional rehabilitation.

Discussion

The present prospective longitudinal follow-up study assessed the clinico-epidemiological profile, selected associated factors and nutritional outcomes among 120 children with Severe Acute Malnutrition (SAM) admitted to a District Nutritional Rehabilitation Centre (NRC) in Maharashtra. The study demonstrated significant improvement in anthropometric parameters during NRC stay and sustained gains during follow-up, indicating the effectiveness of facility-based nutritional rehabilitation combined with continued community-level monitoring.

The mean age of study participants was a 29.75±16.42 month, with the majority of children belonging to the age group of 13- 60 months. Similar age distributions have been reported by Taneja et al. in Madhya Pradesh and Singh et al. in Uttar Pradesh, where most SAM children admitted to NRCs were between one and five years of age.[12,13] This age group is particularly vulnerable to growth faltering because of increased nutritional requirements, transition to complementary feeding and frequent exposure to infectious diseases.

Female children constituted 60.8% of the study population. A female preponderance among NRC admissions has also been observed in certain Indian studies; although findings vary across regions.[11,13] Gender differences may reflect local sociocultural practices, healthcare-seeking behaviour and differential vulnerability to undernutrition. However, SAM affects both sexes and remains a major public health concern irrespective of gender.

The majority of children in the present study belonged to lower socioeconomic strata, with nearly all families falling within Modified BG Prasad Classes IV and V. Similar observations have been reported by Bhadoria et al. and Meshram et al., who identified poverty and socioeconomic deprivation as major determinants of childhood undernutrition in India.[8,9] Poor household purchasing power, food insecurity and limited access to healthcare services contribute substantially to the development and persistence of severe malnutrition.

Maternal educational attainment was generally low among study participants. More than three-fourths of mothers were either illiterate or educated only up to the primary level. Maternal education has consistently been identified as an important determinant of child nutrition because it influences feeding practices, healthcare utilization, hygiene behaviours and care-seeking decisions. Black et al. and Victora et al. reported that improvements in maternal education are associated with better nutritional and developmental outcomes among children.[3,4] In the present study, maternal education demonstrated a significant positive association with long-term weight gain, highlighting its role in sustaining nutritional recovery after discharge.

Suboptimal infant and young child feeding practices were common among participants. Inadequate exclusive breastfeeding and inappropriate complementary feeding practices have been widely recognised as major contributors to childhood malnutrition. The WHO Complementary Feeding Guideline emphasizes the importance of timely initiation of complementary feeding, dietary diversity and continued breastfeeding for optimal growth and development. The borderline association observed between exclusive breastfeeding and nutritional recovery in the present study further supports the importance of early-life feeding practices in determining subsequent nutritional outcomes.

A key finding of the study was the significant improvement in anthropometric indicators during NRC stay and follow-up. Mean body weight increased from 7.91±2.11 kg at admission to 9.23 ± 2.22 kg at discharge and continued to improve during follow-up. Similar improvements in weight gain have been reported from NRC evaluations conducted in Madhya Pradesh, Uttar Pradesh and Rajasthan[12,13,14]. Facility-based nutritional rehabilitation provides therapeutic feeding, medical treatment of co-morbidities and intensive caregiver counselling, all of which contribute to nutritional recovery.

The mean weight gain velocity observed in the present study was 11.76 ± 4.56 g/kg/day. This finding is higher than the minimum programme benchmark of 5 g/kg/day recommended for satisfactory recovery and is comparable to or higher than values reported from several Indian NRC studies[12,13]. The high proportion of children achieving satisfactory weight gain (93.3%) suggests effective implementation of NRC protocols and adherence to therapeutic feeding schedules.

In addition to weight gain, significant improvements were observed in MUAC, height/length and chest circumference during follow-up. Improvement in MUAC is particularly important because it is a reliable indicator of acute nutritional status and is commonly used for community-level screening of SAM. Similar trends have been reported in studies evaluating long-term outcomes following nutritional rehabilitation.[15,17] The sustained anthropometric gains observed in the present study indicate that recovery extended beyond the inpatient phase and continued after discharge.

Family size demonstrated a significant negative correlation with weight gain during NRC stay. Children from larger families may experience greater competition for food, caregiver attention and household resources. Similar associations between larger family size and poor nutritional outcomes have been documented in several epidemiological studies of childhood undernutrition.[8,9] In contrast, socioeconomic status did not demonstrate a significant association with short-term weight gain during NRC stay, possibly because standardized inpatient nutritional care minimizes disparities related to household economic conditions during the rehabilitation period.

An important strength of the present study was the complete follow-up of all enrolled participants. No mortality and no loss to follow-up were recorded during the study period. Longitudinal follow-up studies of SAM children frequently encounter attrition, which can affect the validity of outcome assessment. Complete follow-up enhanced the reliability of the present findings and allowed comprehensive evaluation of long-term nutritional recovery.

The findings of the present study have important programmatic implications. While Nutritional Rehabilitation Centres remain an effective strategy for management of Severe Acute Malnutrition, long-term recovery depends not only on facility-based care but also on sustained caregiver counselling, appropriate feeding practices, regular growth monitoring and community-based follow-up. Strengthening convergence between NRCs, Integrated Child Development Services (ICDS), Poshan Abhiyaan, Rashtriya Bal Swasthya Karyakram (RBSK) and primary healthcare services may further improve nutritional outcomes and reduce the risk of relapse among vulnerable children.

Strengths

- Prospective longitudinal follow-up design with assessment up to 360 days post- discharge.
- Complete follow-up of all enrolled participants with no mortality and no loss to follow-up.
- Evaluation of multiple anthropometric indicators including weight, height/length, MUAC and chest circumference.
- Conducted in a real-world programme setting, enhancing the operational relevance of findings for Nutritional Rehabilitation Centre services.

Limitations: The study was conducted at a single centre and lacked a comparison group, which may limit the generalizability and causal interpretation of the findings. Some information obtained from caregivers was subject to recall bias.

Conclusion

The present prospective longitudinal follow-up study demonstrated that children admitted with Severe Acute Malnutrition (SAM) to the District Nutritional Rehabilitation Centre predominantly belonged to socio-economically disadvantaged households and were commonly characterized by low maternal educational attainment and suboptimal infant and young child feeding practices. Significant improvements were observed in weight, height/length, mid-upper arm circumference and chest circumference during NRC stay and throughout the follow-up period, indicating effective nutritional rehabilitation and sustained recovery.

The mean weight gain velocity achieved during NRC stay exceeded recommended programme benchmarks, and the majority of children attained satisfactory nutritional recovery. Maternal education was significantly associated with long-term weight gain, while larger family size adversely influenced short-term nutritional outcomes, underscoring the importance of social and behavioural determinants in the management of severe malnutrition.

The findings support the effectiveness of Nutritional Rehabilitation Centres as an important component of facility-based management of Severe Acute Malnutrition. However, sustained nutritional recovery requires continued caregiver counselling, optimal infant and young child feeding practices, regular growth monitoring and effective community-based follow-up. Strengthening convergence between Nutritional Rehabilitation Centres, Integrated Child Development Services (ICDS), Poshan Abhiyaan, Rashtriya Bal Swasthya Karyakram (RBSK) and primary healthcare services may further improve long-term nutritional outcomes and reduce the risk of relapse among vulnerable children.

Public Health Implications: The study highlights the effectiveness of Nutritional Rehabilitation Centres in improving nutritional outcomes among children with Severe Acute Malnutrition. Strengthening caregiver counselling, growth monitoring and community-based follow-up can help sustain recovery and reduce the risk of relapse.

What is already known?

- Severe Acute Malnutrition (SAM) remains a major contributor to under-five morbidity, mortality and growth failure in India.
- Nutritional Rehabilitation Centres (NRCs) provide facility-based management and utritional rehabilitation for children with Severe Acute Malnutrition.

- Poverty, low maternal education and inappropriate infant and young child feeding practices are important determinants of childhood malnutrition.
- Previous studies have demonstrated short-term improvements in weight gain and nutritional status following NRC-based management.

What this Study Adds?

- The study provides longitudinal evidence on nutritional recovery among children with severe acute malnutrition followed up to 360 days after discharge from a District Nutritional Rehabilitation Centre.
- Significant improvements were observed in weight, height/length, mid-upper arm circumference and chest circumference during NRC stay and follow-up.
- Maternal education was positively associated with long-term nutritional recovery, while larger family size adversely influenced weight gain.
- Complete follow-up with no mortality and no loss to follow-up strengthens the evidence supporting the effectiveness of Nutritional Rehabilitation Centre services in routine programme settings.

Acknowledgement: The authors express their sincere gratitude to all the children and caregivers who participated in this study. The authors also acknowledge the support and cooperation of the staff of the District Nutritional Rehabilitation Centre, District Women Hospital, and the Department of Community Medicine for their assistance during data collection and follow-up activities. The authors are thankful to the Institutional Ethics Committee for granting ethical approval and to all individuals who contributed to the successful completion of the study.

Ethical Approval: Approved by the Institutional Ethics Committee vide Approval No. 431 dated 17/05/2024.

Informed Consent: Written informed consent was obtained from parents/caregivers.

References

1. World Health Organisation. Guideline: Updates on the management of severe acute malnutrition in infants and children. Geneva: World Health Organisation; 2013.
2. World Health Organisation, United Nations Children's Fund. WHO child growth standards and the identification of severe acute malnutrition in infants and children. Geneva: World Health Organisation; 2009.
3. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? Lancet. 2013; 382(9890): 452-477.
4. Taneja G, Dixit S, Khatri AK, Yesikar V, Raghunath D, Chourasiya S. A study to evaluate the effectiveness of nutritional rehabilitation centre in central India. Indian J Community Med. 2012; 37(2):107-111.
5. United Nations Children's Fund, World Health Organisation, International Bank for Reconstruction and Development the World Bank. Levels and trends in child malnutrition: UNICEF-WHO-World Bank Joint Child Malnutrition Estimates. New York: UNICEF; 2024.
6. International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-5), 2019–21: India Report. Mumbai: IIPS; 2021.
7. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: Consequences for adult health and human capital. Lancet. 2008; 371 (9609):340-357.

8. Lenters LM, Wazny K, Webb P, Ahmed T, Bhutta ZA. Treatment of severe and moderate acute malnutrition in low- and middle-income settings: A systematic review, meta-analysis and Delphi process. Food Nutr Bull. 2013; 34 (3 Suppl): S308-S319.
9. World Health Organisation. Guidelines on complementary feeding of infants and young children. Geneva: World Health Organisation; 2023.
10. Ministry of Health and Family Welfare, Government of India. Operational Guidelines on Facility-Based Management of Children with Severe Acute Malnutrition. New Delhi: MoHFW; 2021.
11. Ministry of Health and Family Welfare, Government of India. Nutritional Rehabilitation Centres Operational Guidelines. New Delhi: MoHFW; 2021.
12. Singh K, Badgaiyan N, Ranjan A, Dixit HO, Kaushik A, Kushwaha KP. Management of children with severe acute malnutrition: Experience of nutritional rehabilitation centres in Uttar Pradesh, India. Indian Pediatr. 2014; 51(1):21-25.
13. Choudhary M, Sharma D, Nagar RP, Gupta BD, Nagar T, Pandita A. Clinical profile of severe acute malnutrition in western Rajasthan: A prospective observational study from India. J Clin Diagn Res. 2015; 9(7):SC01-SC04.
14. Dasgupta R, Sinha D, Yumnam V. Nutritional rehabilitation centres in India: Evidence, challenges and opportunities. Indian J Public Health. 2018; 62(2):123-129.
15. Meshram II, Mallikharjun Rao K, Reddy CG, Ravindranath M, Kumar SS, Sreeramakrishna K, et al. Prevalence of undernutrition and its predictors among under-five children in India. Public Health Nutr. 2018; 21(10):1767-1777.
16. Bhadoria AS, Kapil U, Bansal R, Pandey RM, Pant B, Mohan A. Prevalence of severe acute malnutrition and associated factors among under-five children in India. J Family Med Prim Care. 2017; 6 (2):380-385.
17. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013; 382(9890): 427-451.